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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PS 1828 for a patent by METAL STORM LIMITED as filed on 19 April 2002.



WITNESS my hand this
Twelfth day of May 2003

A handwritten signature in cursive script, reading "J. Billingsley".

JULIE BILLINGSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES

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PROJECTILE SEALING ARRANGEMENT

TECHNICAL FIELD

This invention relates to projectile sealing arrangements for barrel assemblies of weapons wherein a plurality of projectile assemblies are disposed axially in abutting relationship within a barrel and associated with discrete propellant charges for selectively propelling respective projectiles sequentially from the barrel. The invention relates particularly, although not exclusively, to barrel assemblies employing electrical or electronic activation of ignition means for igniting the discrete propellant charges.

BACKGROUND ART

The projectile sealing arrangements described in the present applicant's earlier International Patent Applications, including PCT/AU94/00124, utilise operative sealing engagement between projectile assemblies and the bore of a barrel containing the projectile assemblies.

An important function of operative sealing engagement between projectiles and the barrel bore is to prevent or at least minimise burn leakage of combustion products resulting from firing a leading projectile, which leakage might otherwise cause sympathetic ignition of propellant charges associated with trailing projectiles within the barrel. These projectile assemblies include a variety of barrel seal configurations incorporated in sabots and wedging sleeves, rings or expandable portions - all arranged to seal against the bore of the barrel. However the relative complexity and cost of manufacturing barrel assemblies utilising operative sealing engagement with the barrel detracts from some applications of the applicant's barrel assemblies, especially where high volume, low cost manufacture is anticipated.

OBJECTS OF THIS INVENTION

The invention aims, in certain embodiments, to provide a projectile sealing arrangement for a barrel assembly wherein projectiles are disposed axially in a barrel so as to inhibit the action of firing a leading projectile from igniting the propellant of the rearward or trailing projectiles without a requirement for operative sealing engagement with the barrel.

The invention also aims, in certain embodiments, to provide a projectile sealing arrangement for such barrel assemblies that is less complex, allows use of conventional rifling, facilitates reduced manufacturing cost or at least provides a useful choice.

5 DISCLOSURE OF INVENTION

With the foregoing in view, this invention in one aspect resides broadly in a projectile sealing arrangement for a barrel assembly of a weapon wherein a plurality of projectile assemblies are axially disposed in abutting relationship within a barrel, each projectile assembly associated with a discrete propellant charge; said sealing
10 arrangement comprising:

a rearward opening communicating with a cavity provided in each projectile assembly for retaining the discrete propellant charge; and

a forward portion of an abutting projectile arranged for operative sealing engagement with the rearward opening;

15 the arrangement being such that, during application of a compressive load to abutting projectile assemblies, the discrete propellant charge is sealed within the cavity.

In another aspect, the present invention resides in a barrel assembly for a weapon; said barrel assembly including:

20 a plurality of projectile assemblies axially disposed in abutting relationship within a barrel, each projectile assembly associated with a discrete propellant charge;

ignition means for each propellant charge, whereby the discrete propellant charges may be selectively ignited to propel respective projectiles sequentially from the barrel; and

25 a sealing arrangement between abutting projectile assemblies, said sealing arrangement comprising:

a rearward opening communicating with a cavity provided in each projectile assembly for receiving the discrete propellant charge; and

30 a forward portion of an abutting projectile arranged for operative sealing engagement with the rearward opening;

the sealing arrangement being such that, during the application of a compressive load to the abutting projectile assemblies pursuant to ignition of a leading projectile, the discrete propellant charges for trailing projectiles are sealed within their respective cavities.

In a further aspect, the invention resides in a projectile assembly having a body with a head and a tail portion and characterised in that:

the head includes a forward portion arranged for operative sealing engagement
5 with the rearward opening of a leading projectile;

the tail portion includes a rearward opening communicating with a cavity provided in the projectile assembly for receiving the discrete propellant charge, which opening includes a rear portion arranged for operative sealing engagement with the forward portion of a trailing projectile; and

10 a sealing arrangement being such that, during the application of a compressive load to abutting projectile assemblies pursuant to ignition of the leading projectile, the discrete propellant charge is sealed within the cavity.

Preferably the forward or head portion has a forward sealing surface of a
15 predetermined shape, and the rearward opening has a rearward sealing surface of a complementary shape to the predetermined shape of the forward sealing surface whereby the sealing surfaces cooperate.

Alternatively, either or both of the forward portion and the rearward opening include a sealing means, such as a gasket, to aid or enhance sealing. The sealing
20 means may be pre-formed as a resilient body, such as a gasket, or formed in-situ through the use of a suitable sealing material. Most preferably, the sealing material has adhesive properties.

The sealing surfaces may be of any suitable shape, including planar, hemispherical or wedge shaped surface portions, whether dictated by aerodynamic
25 considerations or otherwise.

The projectile body may include a transverse planar surface on each of the head and tail portions of the projectile assemblies, which planar surfaces are arranged to prevent over-travel of a projectile relative to its trailing projectile upon application of compressive loads thereto.

30 The propellant charges may comprise a solid material or a flowable material, such as powder or granules.

The rearward opening may include a closure for retaining the propellant material within the cavity. The closure may comprise a burstable disc or a disc composed of combustible material.

The closure may include retaining means that releasably engage with complementary retaining means on the head. The retaining means suitable socket and spigot members, that desirably include cooperating screw threads to facilitate release. Alternatively the retaining means may be frangible. In either case a chain of projectile
5 assemblies may be formed by selective engagement of such retaining means.

In a still further aspect, the invention resides in a chain of projectiles including at least two projectiles frangibly coupled together, wherein each projectile comprises a head portion and a tail portion and wherein a frangible coupling comprises a
10 complementary spigot member and socket member, which coupling is disposed between the tail portion of a leading projectile and a head portion of a trailing projectile.

If required the spigot member and socket member of the frangible coupling are provided with releasable engagement means, such as cooperating screw threads.

15 BRIEF DETAILS OF THE DRAWINGS

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings that illustrate typical embodiments of the invention, wherein:

FIG. 1 is an isometric view of a projectile assembly of a first embodiment of the
20 invention;

FIG. 2 is a partially fragmented isometric view of two projectile assemblies of the first embodiment in almost abutting relation within a barrel;

FIG. 3 is an isometric view of a projectile assembly of a second embodiment of the invention;

25 FIG. 4 is a partially fragmented isometric view of two projectile assemblies of the second embodiment; and

FIG. 5 is an isometric view of projectile assemblies including a sealing arrangement of a third embodiment.

30

DESCRIPTION OF PREFERRED EMBODIMENTS

The projectile assemblies 10 of the first embodiment illustrated in FIGs 1 and 2 each include a body 11 having a head or forward portion 12 and a mouth or rearward opening 13 at a tail portion, which opening communicates with a cavity 14 provided in

the projectile. The cavity 14 contains a discrete propellant charge 15 together with ignition means (not shown) for igniting the propellant charge. It will be appreciated that upon ignition of the propellant, suitably by electronic control means, combustion products including propellant gas will exit the projectile cavity 14 via the mouth 13 at the tail of the projectile with considerable force.

In the first embodiment, a forward sealing surface 16 of the projectile head 12 has a simple hemispherical shape, whilst the mouth 13 has a peripheral sealing surface 17 that is provided or formed, at least in part, with a complementary shape to the hemispherical sealing surface 16 of head 12. The precise configuration of the shapes are relatively unimportant, other than the requirement that they be complementary in order to satisfy the desired purpose of providing a substantially gas tight seal to avoid inadvertent ignition of propellant associated with trailing projectiles, as discussed in relation to FIG 2. It is also desirable that the shapes utilised for the projectile provide sufficient strength to withstand the forces that arise during firing of the weapon.

Whilst a simple hemispherical shape is employed in this embodiment, many variations to this are possible. For example, one simple variation is the projectile head and the receiving tail of the projectile have a wedge type shape for improved sealing engagement. In some embodiments, the shape of the surface of the head will be predetermined in accordance with aerodynamic considerations.

FIG 2 illustrates two of a plurality of projectile assemblies 10 axially disposed in nearly abutting relation within a barrel 20. The projectile assemblies are slightly separated and only a fragment of the barrel 20 is depicted for reasons of clarity. In normal operation, the forward surface 16 of the head 12 of the right-hand projectile 10 would be in contact with the rearward peripheral surface 17 of the mouth 13 of the left-hand projectile 10, due to the action of loading projectiles into the barrel. The peripheral surface 17 extends inwardly of the projectile from a rear end annular face 18 on the tail of the projectile, from an outer surface of the projectile body 11 toward a longitudinal axis 19 of the projectile.

Upon the application of compressive load L to the abutting projectiles 10, the rearward peripheral surfaces 17 of the projectiles are operatively sealed against respective forward surfaces 16 of trailing projectiles, thereby sealing the propellant charges 15 within respective cavities 14 in the projectile bodies 11. Typically the compressive load results from ignition of a leading projectile (not shown in FIG 2) during the propulsion of the leading projectile from the barrel 20.

It should be noted that the interaction between the projectile assemblies 10 and the wall or bore 21 of the barrel 20, at least insofar as any requirement for sealing is concerned, is the same as that for conventional projectiles and barrel walls in known weapons. Thus only a level of sealing between the surface of the projectile assembly
5 10 and the bore of the barrel 20 which inhibits propellant gases from escaping past the head 12 of the projectile body 11 during firing, such as provided by conventional rifling, is required.

The projectile 30 of a second embodiment of the invention is illustrated in FIG. 3, which projectile includes a body 31 having a reduced diameter head or forward
10 portion 32 and a mouth or rearward opening 33 at a tail portion which communicates with a cavity 34 provided in the projectile body. The body 31 includes a frusto-conical tail portion which terminates at an annular rear face 38 having a reduced diameter relative to the projectile body generally. The cavity 34 contains a discrete propellant charge 35 together with ignition means (not shown) for igniting the propellant charge.
15 The arrangements for igniting the propellant charge may suitably be similar to those described in the present applicant's earlier International Patent Application PCT/AU94/00124.

A forward sealing surface 36 is provided on the projectile head, together with a complementary rearward sealing surface 37 of the rearward opening 33, which is
20 arranged for sealing engagement with the sealing surface 36 of projectile head 32.

FIG. 4 illustrates two projectiles 30 of the second embodiment in substantially axial alignment, although they are spaced apart for clarity. If required, a front face of the projectile body 31 may include an annular portion (not shown) transverse to a longitudinal axis 39 and arranged to abut the annular rear end face 38 of a leading
25 projectile. This arrangement might be provided to limit the travel of the head 32 of a trailing projectile into the mouth 33 of a leading projectile, thus minimising the possibility of the respective sealing faces 36, 37 becoming locked together through over-travel and/or deformation caused by repeated application of compressive forces to a chain or stack of projectile assemblies in a barrel.

Turning to FIG. 5, there is shown projectile assemblies 40 of generally similar
30 configuration to that described above in relation to FIGs 1 and 2. Each assembly 40 includes a sealing means in the form of a gasket 41 retained on the rearward sealing surface 42 of an opening 43 adjacent the projectile tail. The gasket 41, which may be composed of stainless steel or a suitably specified synthetic material, provides for

enhanced sealing between the rearward sealing surface 42 and the forward sealing surface 44 on the projectile head. A double seal may be achieved by providing a second gasket on the projectile head. However, sealing means disposed on the projectile head can detract from the aerodynamic performance of the projectile.

5 In other embodiments, the sealing means may comprise an adhesive sealing material that forms a seal between the projectiles in situ, and might also function to retain a plurality of projectiles in a chain for ease of loading into a barrel. A propellant charge 45 is retained with the body of the projectile assembly 40, and may be formed as a solid block or as flowable material, such as powder or granules, as in the present
10 embodiment.

 The embodiment further includes a closure for the rearward opening 43 in the form of a burstable disc 46 for retaining the flowable propellant charge 45. The closure, which may alternatively be formed of a combustible material rather than a burstable disc, includes retaining means that releasably engage with complementary retaining
15 means on the projectile head. The retaining means in the present embodiment are a spigot member 47 on the head, and socket member 48 provided in the burstable disc 46, which include cooperating screw-threads allowing subsequent release as desired.

 In other embodiments using a solid block of propellant, retaining means may include a socket formed in the propellant block.

20 The spigot and socket members of the retaining means may together comprise a frangible coupling. Rather than cooperating threads, the coupling may be released with the assistance of combustion, such as present during firing. A plurality of projectile assemblies 40 can accordingly be coupled together to form a chain of projectiles for ease of handling and subsequent loading into a barrel.

25 The present invention has application to weapons for both military and law enforcement uses, although this invention is also applicable for other civilian uses. It has particular application to weapon systems in that it greatly reduces the stress requirements of the barrel and projectile, which also simplifies the manufacturing process. In particular, projectiles including the sealing arrangement of the invention may
30 be utilised with barrels that employ standard construction techniques, including conventional rifling arrangements, as well as with more specialised barrels and weapons.

 It is to be understood that the above embodiments have been provided only by way of illustration of this invention and that further modifications and improvements

thereto, as would be apparent to persons skilled in the relevant art, are deemed to fall within the broad scope and ambit of the present invention described herein.

DATED THIS NINETEENTH DAY OF APRIL 2002

5 **METAL STORM LIMITED**

by

PIZZEYS Patent and Trade Mark Attorneys

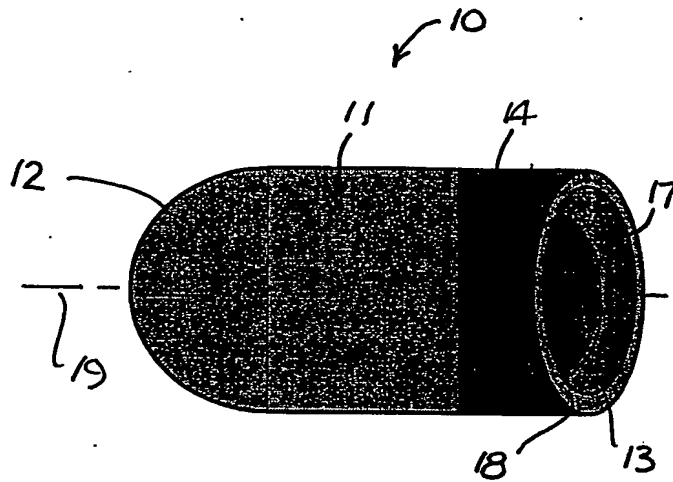


Fig. 1

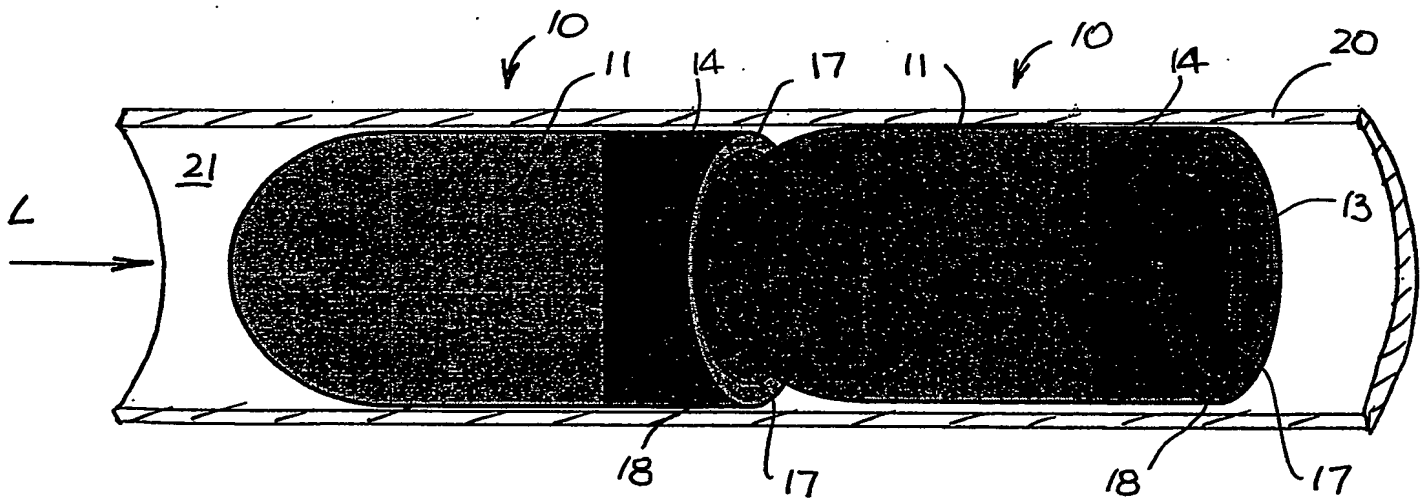


Fig. 2

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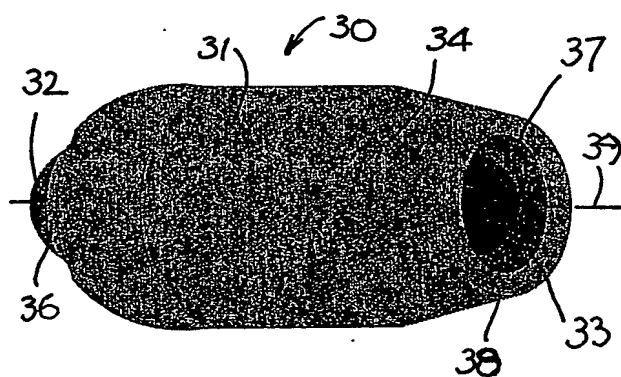


Fig. 3

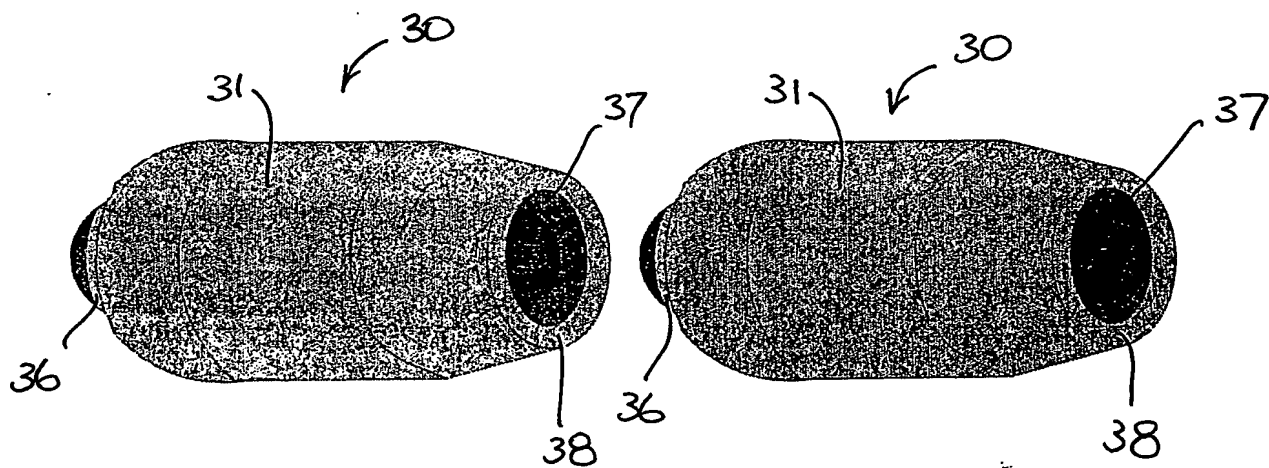


Fig. 4

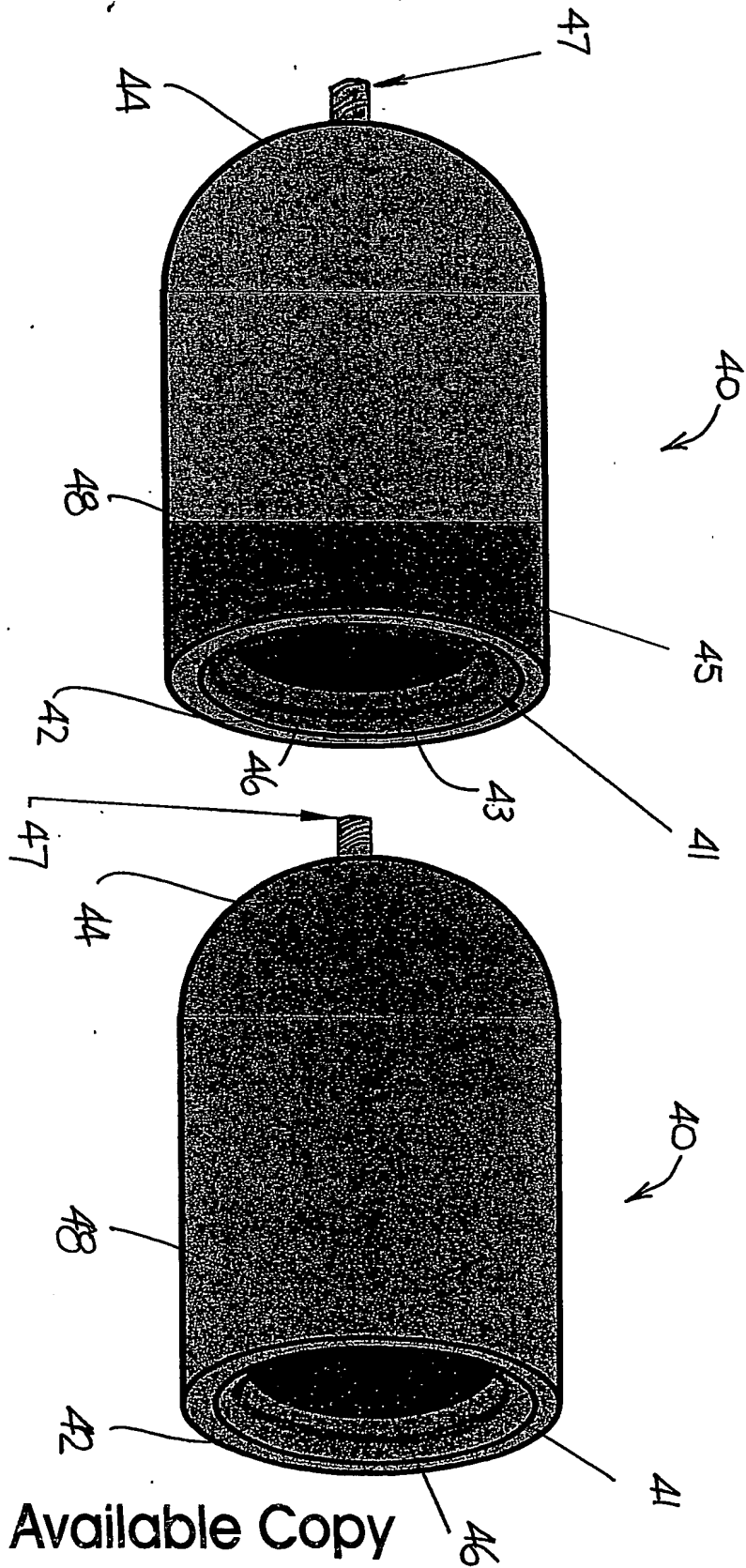


Fig. 5